

Rats Play Doom

Hardware Setup Guide

This guide explains how to build the full system, as far as the hardware goes. Each section includes a Blender file for 3D visualization and 3D printing of custom parts. Blender is used to design and position components, so you can see how everything fits together.

KiCad files are included for electronics. KiCad is a tool for designing circuit boards and wiring diagrams. Use these files to connect sensors, motors, encoders, pumps, and other components correctly.

Follow each section step-by-step. Always refer to the listed files when assembling mechanical or electronic parts.

1. Frame Assembly

Blender file: [frame.blend](#)

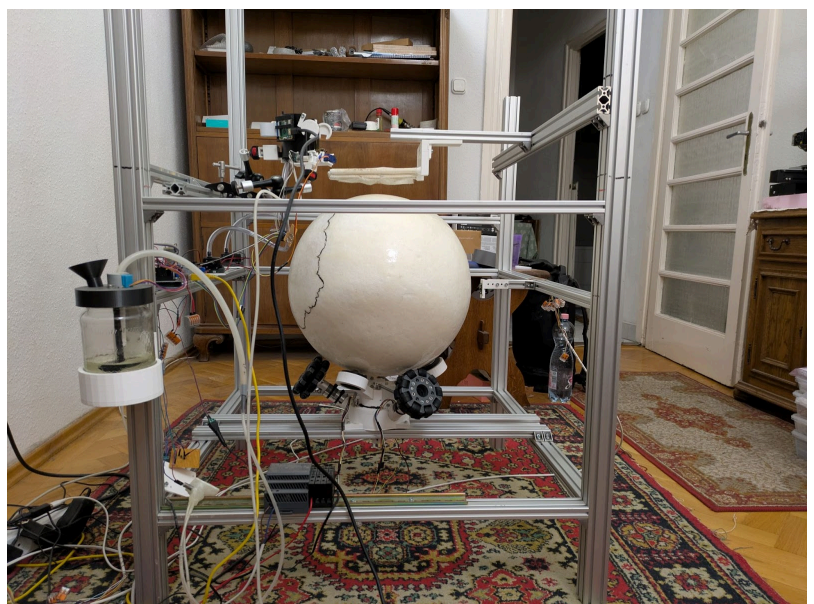
The frame is built from aluminum profiles. This material makes it easy to attach all modules and adjust their positions.

Parts list (number × dimensions in cm):

- Pillars: 4 × 100×4×4
- Crossbeams: 10 × 70×4×2
- Motor mount: 2 × 80×4×2
- Sensor mounts: 2 × 10×2×2
- VR mount: 1 × 60×4×2
- Harness mounts: 1 × 80×4×2 and 1 × 30×4×2

Frame levels:

- Bottom: holds the locomotion system
- Middle: holds sensors and reward circuit
- Top: holds the VR and harness system



2. Locomotion

Blender file: [spawn_base_ver3_18a.blend](#)

KiCad files: [raspby_to_hw95](#), [motor](#), [hwstohdr](#)

Install the locomotion system on the bottom level of the frame. It lets the rat move a ball in two modes:

- **Active Mode:** motors move the ball based on software commands.
- **Passive Mode:** the rat moves the ball directly; motors are off.

Parts:

- Bottom and top locomotion bases
- 3 × linear motor encasing tubes
- 3 × support arms
- Round housing for ball bearings
- 3 × 100 mm omnidirectional wheels
- 3 × 8 mm shaft universal mounting hubs
- 3 × Pololu 99:1 gearmotors (25Dx69L mm, 12V, with 48 CPR encoders)
- 1 × mini electric linear actuator (4" stroke, 12V, high speed)
- 1 × 40 cm (16") styrofoam ball

Assembly steps:

1. Place linear actuator into the bottom base, moving leg upwards.
2. Attach the top base.
3. Slide motor tubes into the bottom plate; mount shaft enlarger to the motor shafts. [TODO NEED LINK FOR HOW TO MAKE THIS]
4. Mount wheels onto the enlarged motor shafts.
5. Insert arms into the base. [TODO NEED LIST OF CSAVAROK]
6. Fit the ball bearing housing into the arms.
7. Insert ball bearings.

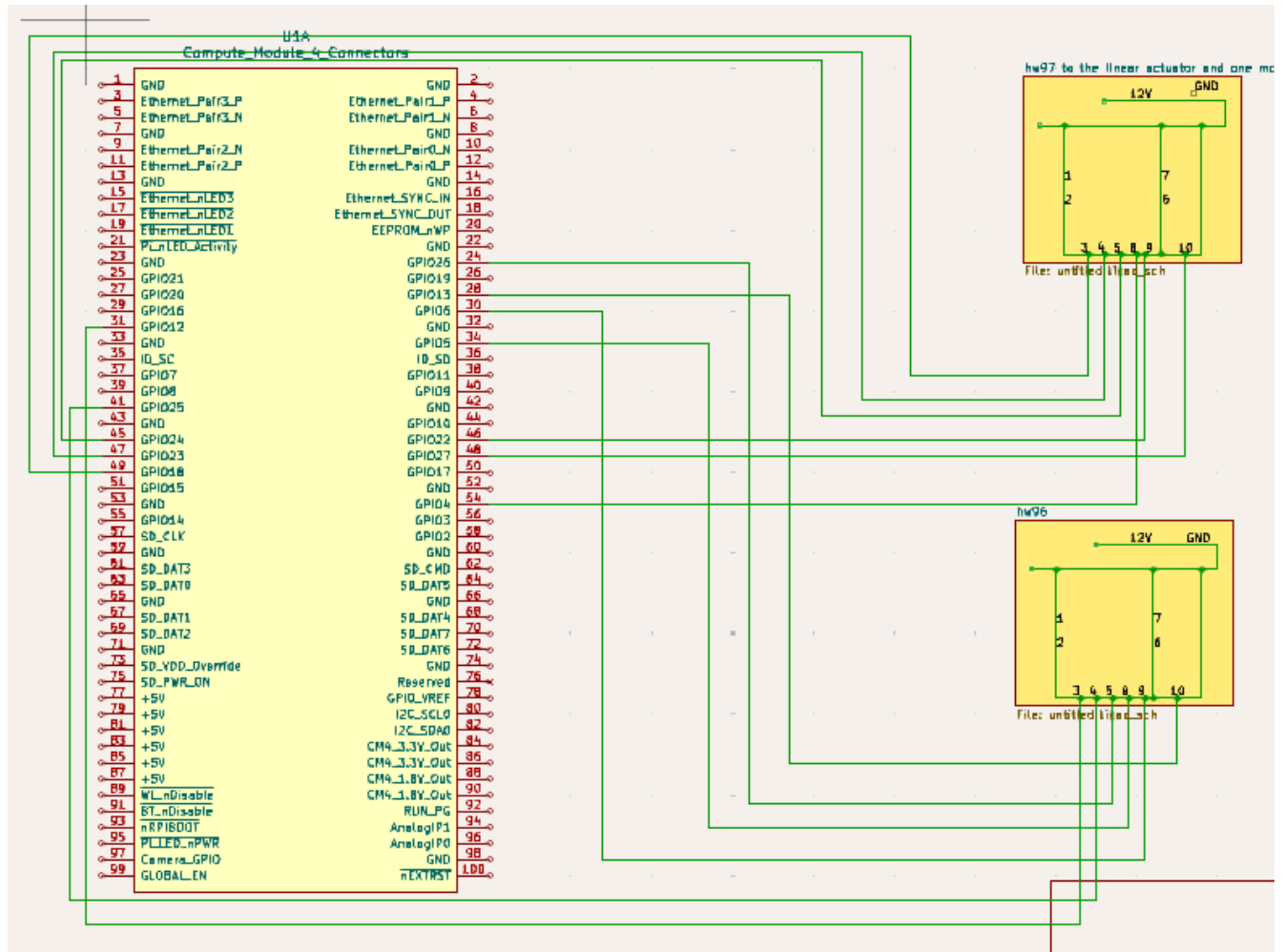
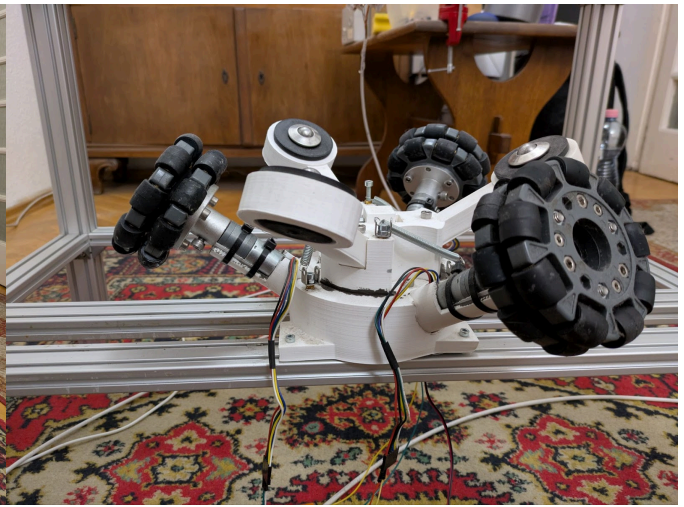
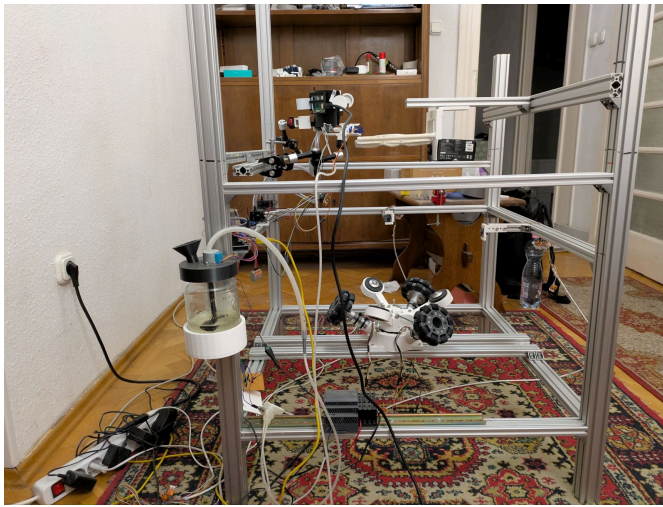
[3D ANIMATION OF BASE ASSEMBLY]

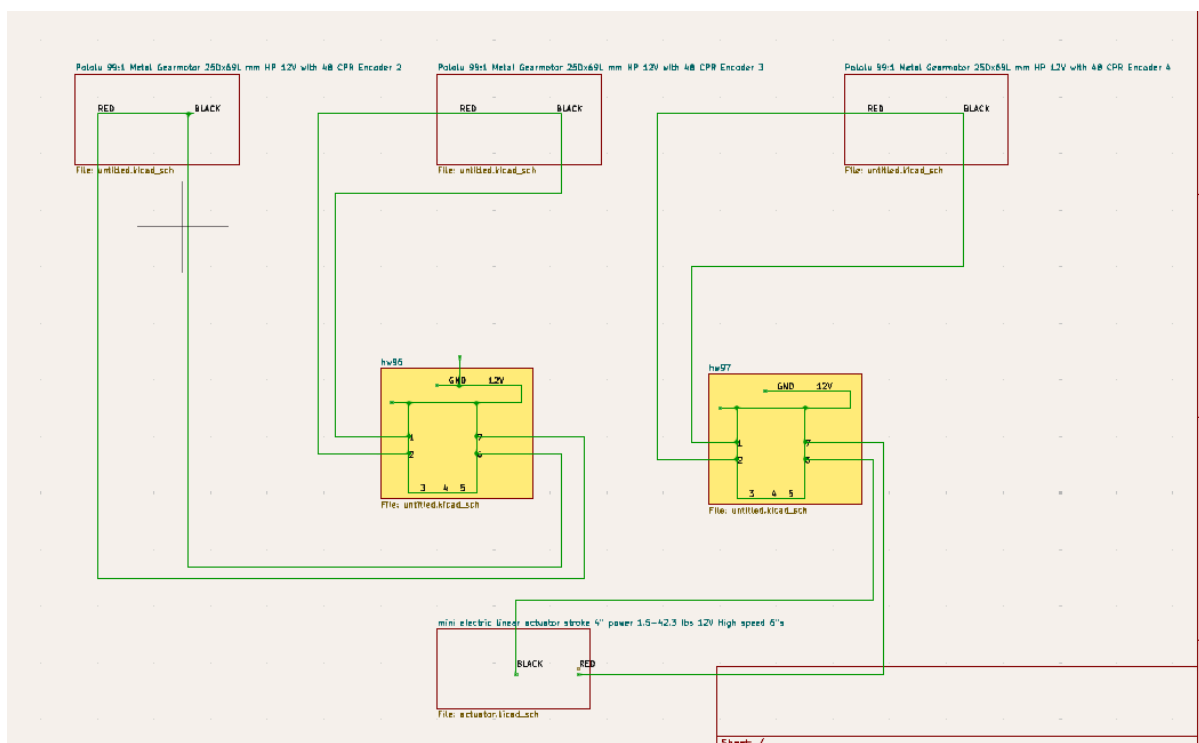
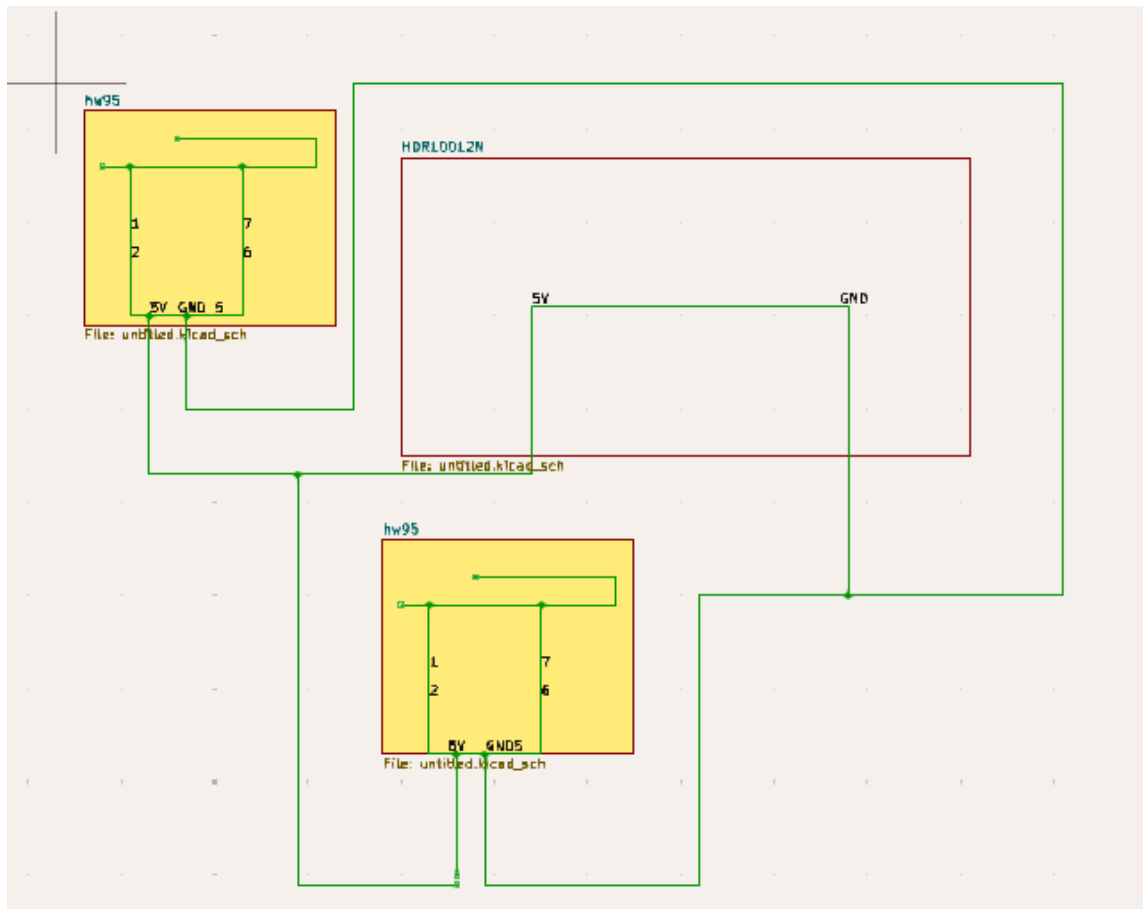
Electronics:

- Use 2 × HW95 motor drivers, 1 × HDR-100-12N power supply, linear actuators, and encoders.
- Connect HW95s to the Raspberry Pi and power using the KiCad wiring maps. Then connect actuators and encoders.

Final step:

- Coat the styrofoam ball with a single layer of transparent Flex Seal Liquid. [TODO NEED MORE DESCRIPTION HERE]
- Mount it on top of the locomotion unit, centered in the frame.
- The ball must be light and easy for the rat to move with its paws.





The styrofoam ball has to be placed onto the locomotion after it was covered with flex steal liquid.

3. Ball sensors

Blender file: [motion_sensor_mount.blend](#)

KiCad file: [sensors](#)

Install the sensors to track how the rat moves the ball. Use two optical motion sensors and their frame mounting custom 3D part.

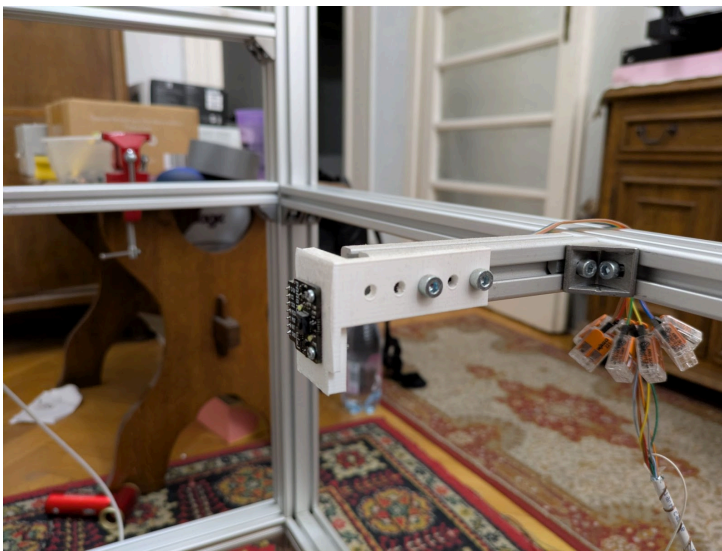
Parts:

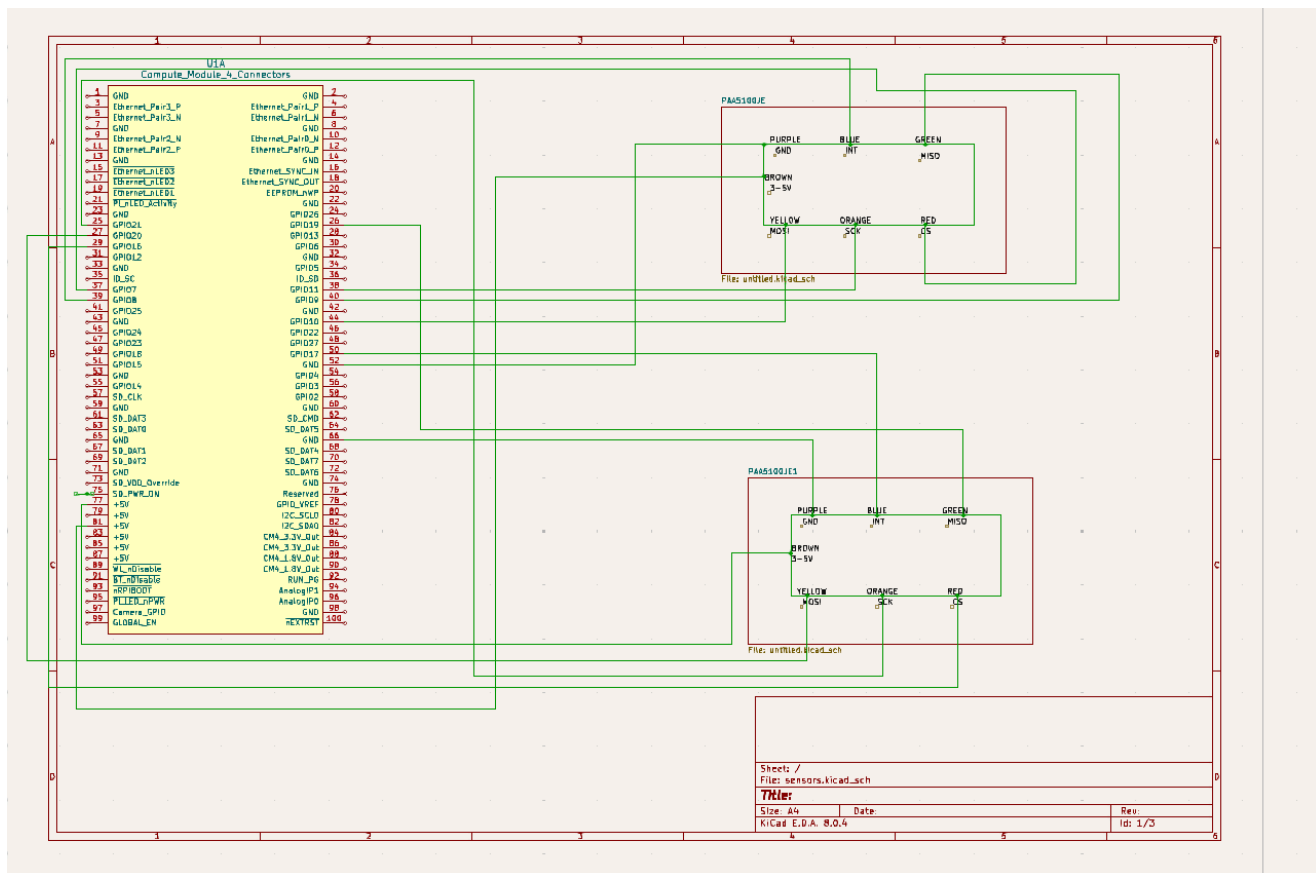
- 2 × sensor mounts
- 2 × PAA5100JE optical motion sensors

Instructions:

1. Mount the sensors onto the frame at 90° angles to each other. [TODO SHOOT AN IMAGE OF THIS]
2. Make sure both have a clear view of the ball from different sides.
3. Fix them securely so they don't shift during use.

These sensors detect ball movement and send signals to the system for input tracking.





4. Reward Circuit Installation

Blender file: [mixer_cap.blend](#)

KiCad files: [valve](#), [waterpump](#), [stepmotor+pressuresensor](#), [blowsystem](#)

The reward system gives sugar water when the rat does the right action. It also uses an air puff to signal when the rat hits a wall.

Parts:

- 2 × 12V water pumps
- 1 × water pressure sensor (MPX5700AP)
- 1 × capacitor (16V, 100μF)
- 1 × valve [TODO WHAT VALVE]
- 1 × 2.2kΩ resistor
- Pipe: 10/6 mm and 4/2 mm (outer/inner diameters)
- 1 × servo motor [TODO WHAT SERVO MOTOR]
- 2 × air blower (2 high-pressure pumps)
- 3D printed parts: reservoir holder, mixer, water_tube_adapter_6to2

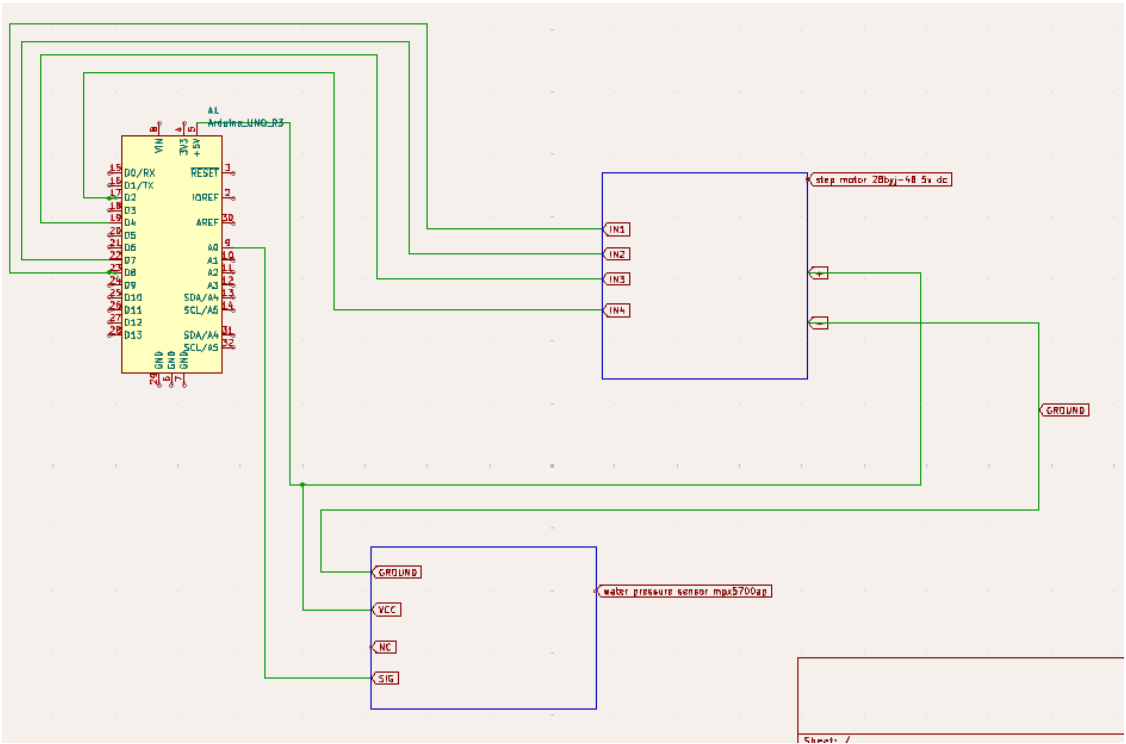
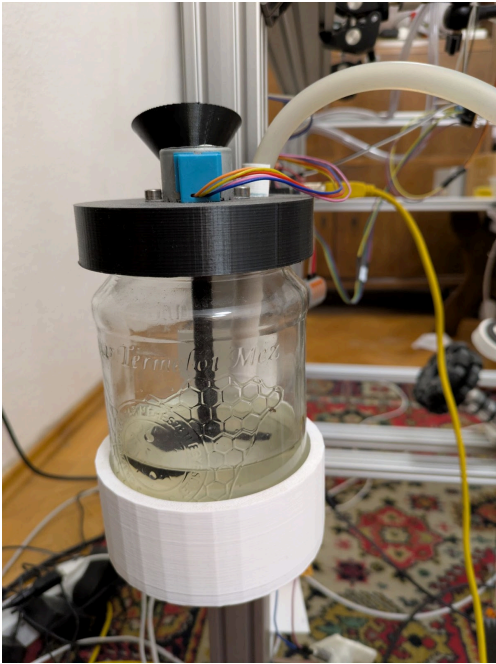
Assembly steps:

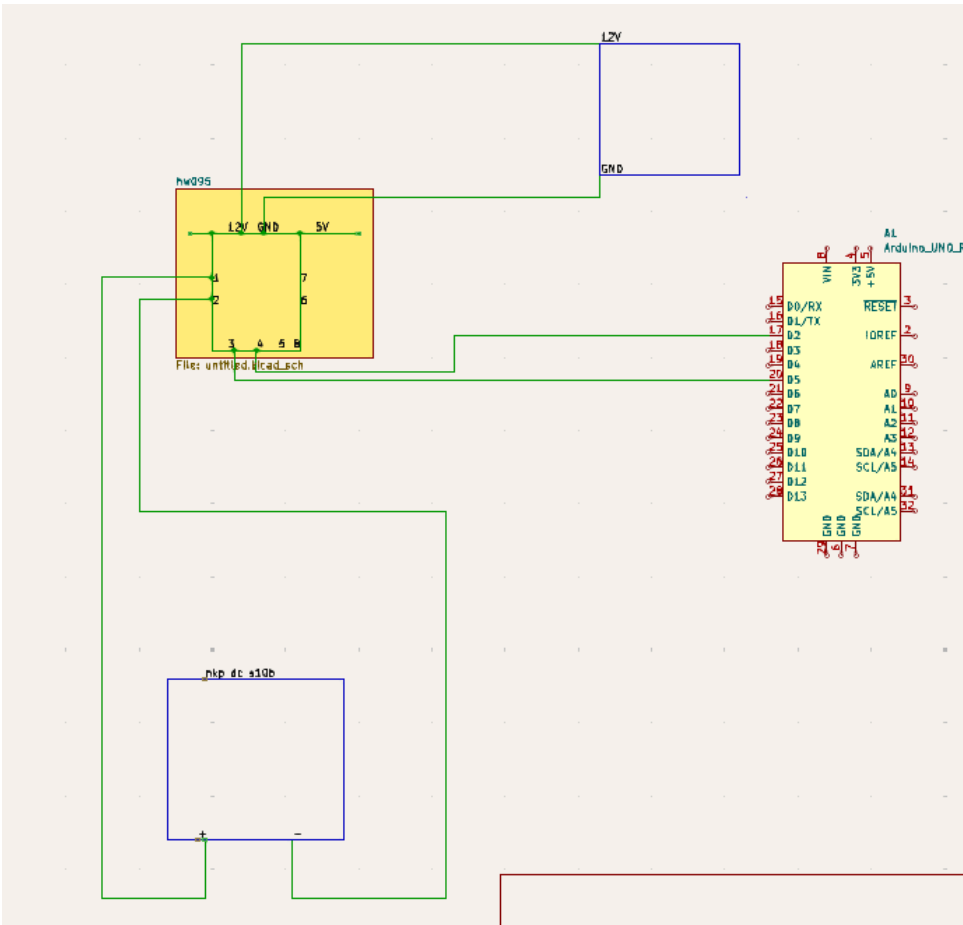
1. Print and mount the reward reservoir near the rat.
2. Fill a jar with sugar water and place it in the holder.
3. Attach a servo motor to stir the mix using the mixer cap.
4. Connect the large pipe to the pump, then reduce it to small pipe using the adapter.
5. Add a T-junction after the pump. One branch goes to the pressure sensor.
6. Mount the valve after the pressure sensor. It ensures fast reward delivery.

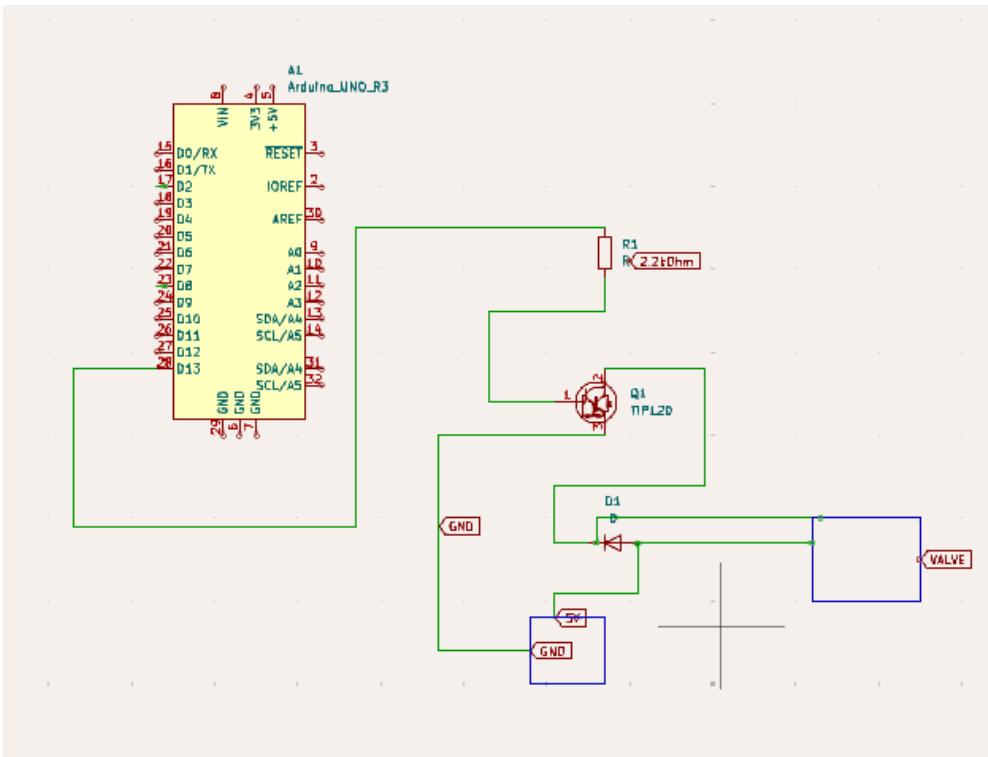
Air puff system:

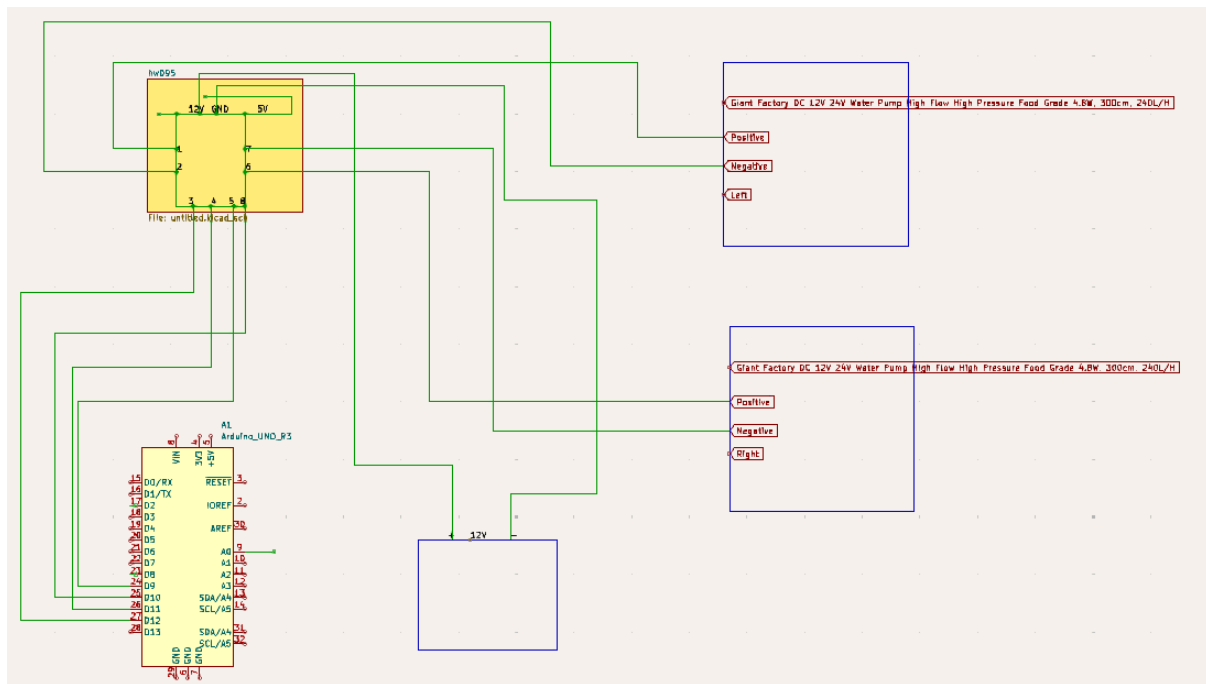
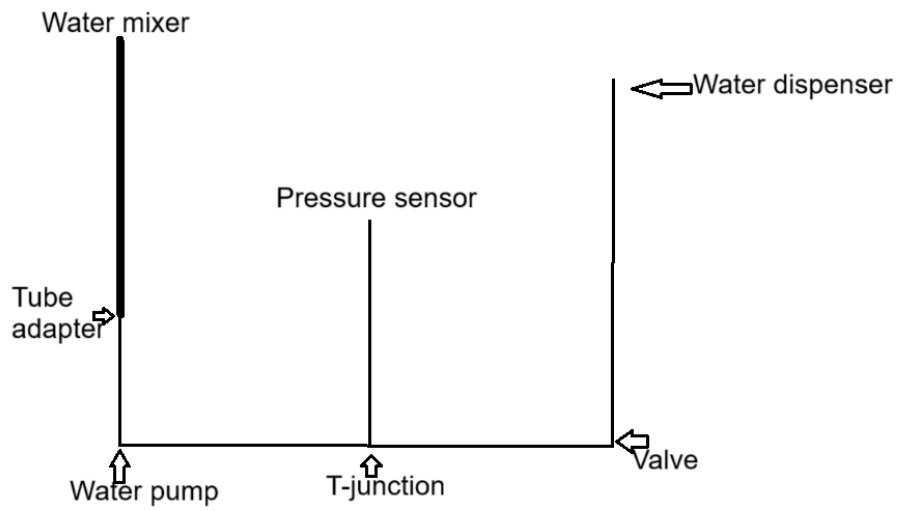
1. Place the air blower near the VR headset to aim air at the rat's face.
2. Connect the blowers to a HW95 driver and an Arduino.

This setup reinforces correct actions with reward and gives negative feedback with air puffs.









5. Trigger Mechanism

Blender file: [vr_headset6_rev15_lever3_a8.blend](#)

KiCad file: [trigger](#)

This part lets the rat "shoot" in the game using a lever.

Parts:

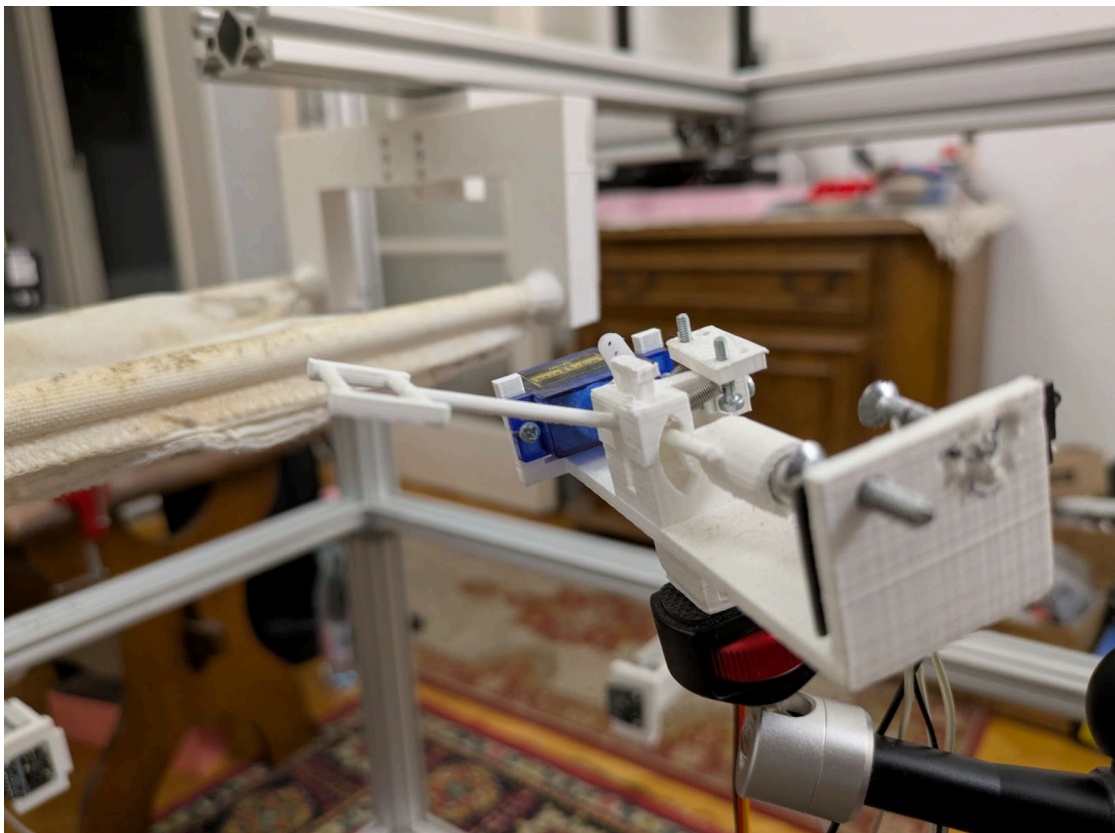
- Lever
- Bottom and top housing
- Spring holder
- Servo motor (SG90)
- Rotary encoder (Keyestudio)
- 2 × springs (E0063-007-0380S)

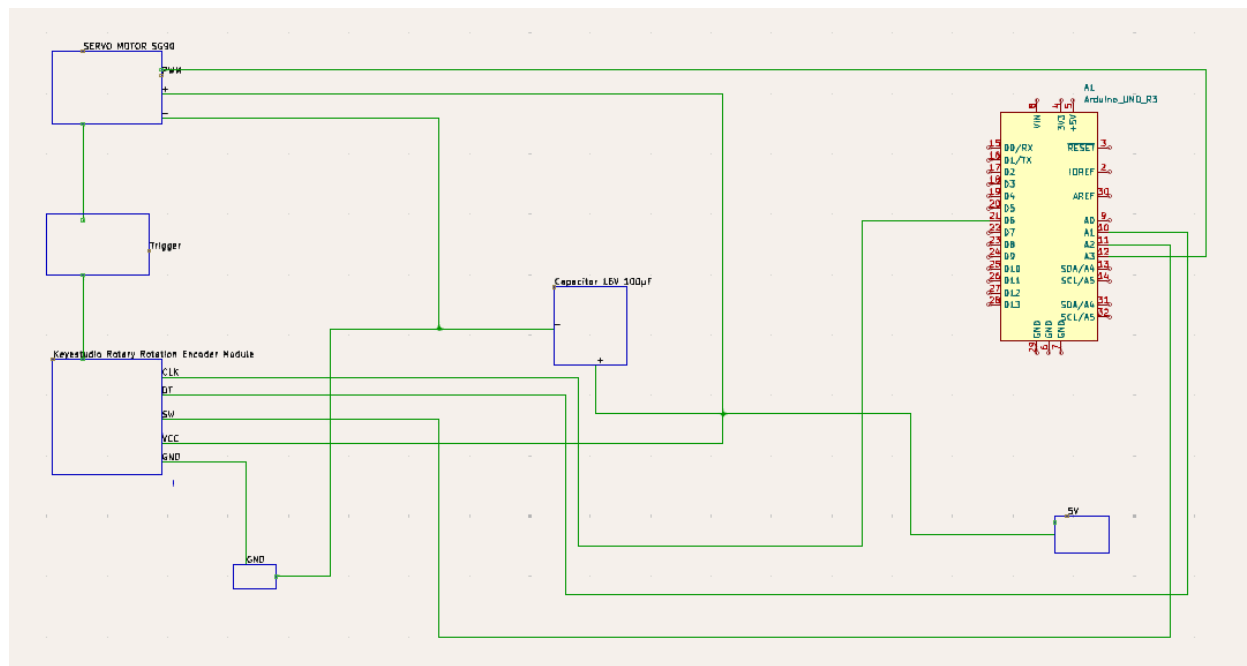
Assembly steps:

1. Mount the encoder to the side with holes in the housing.
2. Attach the servo motor to the opposite side.
3. Place the lever into the bottom housing. One end connects to the encoder, the other to the motor.
4. Add the top housing.
5. Screw the spring holder to the top housing.
6. Attach springs between the holder and the lever arm.

Mount the whole trigger unit on an adjustable arm. Place it so the rat can reach it easily without moving far from the ball.

The lever sits in a small platform. A container sits on top of the lever.





6. Display System

Blender file: [full_headset_guide.blend](#)

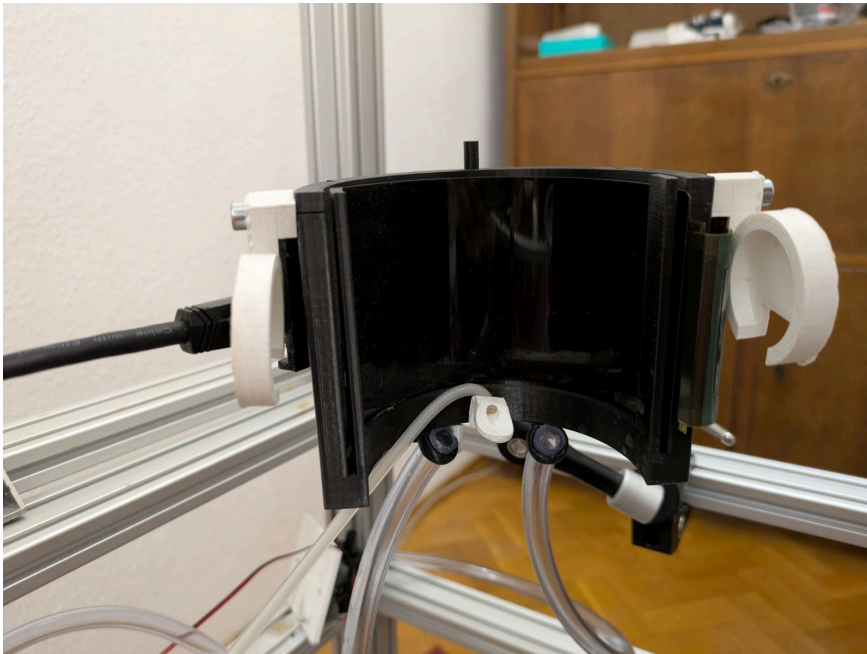
This part shows the DOOM gameplay to the rat.

Steps:

1. 3D print the screen holder.
2. Mount the LED screen inside the holder.
3. Attach the holder to an adjustable arm.
4. Position the screen at the rat's eye level and angle it for clear visibility.

The screen gives real-time visual feedback during the game.

[TODO ELABORATE, HAVE VR HEADSET 3D ANIMATION HERE]



7. Rat Harness System

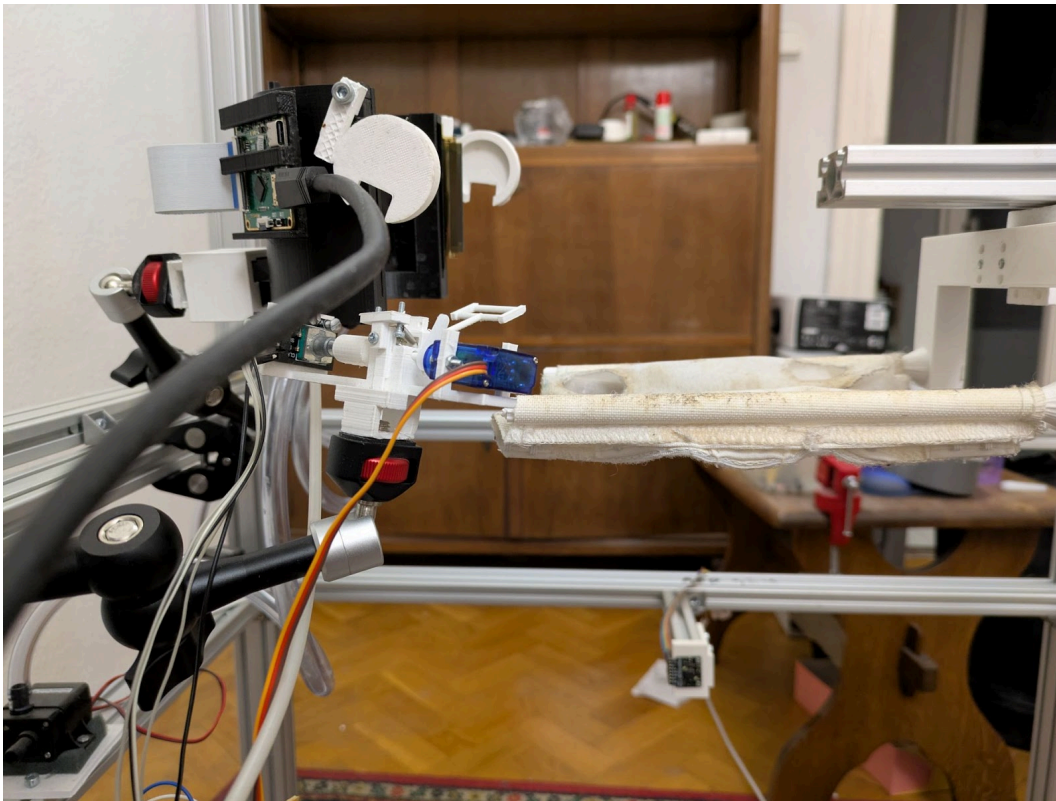
Blender file: [harness.blend](#)

The harness holds the rat above the ball, letting it move freely without walking away.

Steps:

1. Mount the harness to the top level of the frame.
2. Adjust it so the rat hangs comfortably, with its paws resting on the ball.
3. Allow slight vertical movement but prevent full body movement or escape.

The harness must support the rat without causing stress.



Links for the hardware used:

- T-junctions: <https://www.terkowebaruhaz.hu/Mikro-idom-T-idom-4-mm>
- Fuse holder:
<https://hu.rs-online.com/web/p/din-sinre-szerelhető-sorkapcsok/7684611?searchId=376146d0-f38a-4a21-bc80-250320de0ab5&gb=s>
- Fuses:
 - <https://hu.rs-online.com/web/p/uveg-biztositekok/6686029?searchId=45b5a2f8-5920-46b4-90a5-ca815e91c9f5&gb=s>
 - <https://hu.rs-online.com/web/p/uveg-biztositekok/6686082?searchId=97986449-ef2e-4fb4-b201-0e98ca752ec0&gb=s>
 - <https://hu.rs-online.com/web/p/uveg-biztositekok/0412223?searchId=59e0979b-0863-40fc-a4b9-eccc364db66c&gb=s>
 - <https://hu.rs-online.com/web/p/uveg-biztositekok/6686032?searchId=dc225008-39bb-4b1b-a3e9-5d648ff40430&gb=s>
- Springs:
 - <https://biotek.hu/termek/asp06120-e0063-007-0380s>
 - <https://biotek.hu/termek/asp06168-e0094-010-0380s>
 - <https://rugobolt.hu/Huzorugo-07x64x58-mm-A-69-horganyzott>
 - <https://rugobolt.hu/Huzorugo-07x60x14-mm-A-25-horganyzott>
 - <https://rugobolt.hu/Huzorugo-08x7x35-mm-A49-mm-horganyzott>
- Power supplies:
 - <https://www.elektrobot.hu/termek.php?filename=7386.html&i=7386>
 - https://www.hestore.hu/prod_10038317.html
 - https://www.hestore.hu/prod_10040292.html
 - https://www.hestore.hu/prod_10040837.html
 - https://www.hestore.hu/prod_10041317.html
 - https://www.hestore.hu/prod_10042653.html
 - https://www.hestore.hu/prod_10040955.html
 -
- Air pump: https://www.hestore.hu/prod_10041524.html
- Pipe: https://www.hestore.hu/prod_10042175.html
- Loudspeaker: https://www.hestore.hu/prod_10029791.html
- Servo motor: https://www.hestore.hu/prod_10031188.html
- Flex seal: https://www.amazon.co.uk/dp/B019PFO4MA/ref=pe_27063361_485629781_TE_item
- Pressure sensor: <https://wiki.seeedstudio.com/Grove-Integrated-Pressure-Sensor-Kit/>
- OLED display:
https://www.aliexpress.com/item/1005003546051861.html?spm=a2g0o.order_detail.order_detail_item.3.2aecf19crKoEf1
- For the screws:
 - https://www.tme.eu/en/details/b4x8_bn3/bolts/bossard/1003909/
 - <https://www.tme.eu/hu/details/fa-096214/profil-kellekek/fath/096214/>
 - https://www.tme.eu/hu/details/m4x14_d912-a2/csavarok-anyaval/kraftberg/
- Encoder: <https://www.pololu.com/product/4867>
- Omniwheel:
<https://eu.robotshop.com/products/100mm-omnidirectional-wheel-brass-bearing-rollers>
- Mounting hub: <https://eu.robotshop.com/products/8mm-shaft-universal-aluminum-mounting-hub>
- L298N:
https://www.hestore.hu/prod_10036621.html?lang=en&srsId=AfmBOoo-VflyRqYeY5S0FqXZlgyECYAzuxvi8KfoRXqlp_KPFMFRFzex